Ministry of Transportation Ontario

MI-124

AN EVALUATION OF BITUMINOUS TEST SECTIONS - VOLUME 1

-Anti-stripping additives

-Bridge deck waterproofing

-Recycling

-Emulsified primers

-Crack sealing compounds

-Surface treatments

-Triple-jointed-screed paver

MATERIALS INFORMATION

ENGINEERING MATERIALS OFFICE

AN EVALUATION OF BITUMINOUS TEST SECTIONS - VOLUME 1

-Anti-stripping agents
-Bridge deck waterproofing
-Recycling
-Emulsified primers
-Crack sealing agents
-Surface treatments
-Tensar Geogrid
-Triple-jointed-screed paver

BY

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ENGINEERING MATERIALS OFFICE

BITUMINOUS SECTION

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Abstract

The Bituminous Section of the Engineering Materials Office has initiated a large number of experimental sections to study the performance of new materials, equipment or construction methods. Frequently, the assessment of these trials has not been followed up and their long term performance never established. A program to rectify this situation and to carry out the assessments was put into effect during 1988 and this report is the first of a series which describes the precise location of the trials, assesses the performance of the experimental sections to date and makes recommendations for future work, where applicable.

1. Introduction

Over the past 15 years or so the Bituminous Section of the Engineering Materials Office has been responsible for establishing a large number of experimental sections on the Ontario highway system. These trials were intended to study the effect of changing some aspect of the material's make up or of the construction procedure and, generally, to compare their performance against a control section of standard material laid in a conventional manner.

Many of these trials were constructed at the request of private organizations who had made some development that they believed would be beneficial to the pavement performance and that they could market once proven. This could take the form of a proprietary material or additive or a development to the paving or compaction equipment.

Other trials were initiated within the Ministry and typically involved the use of an alternative design of mix or source of aggregate of a non-proprietary nature.

In many cases, follow-up work on the trial sections has not been carried out and the long term performance of the trials never determined. The purpose of this report is therefore three-fold:

1) To identify the trial location;

2) To assess the performance to date; and

3) To make recommendations for further work where required or to discontinue the trial if appropriate.

Many of the trials have been concluded and a summary of the findings is presented in this report for completeness. It is still possible to obtain additional useful data from other trials and a summary of the findings up to the summer of 1988 is given together with some recommendations for future work.

2. Test Site Location

Re-locating the test sites has proven to be a very time consuming process. When establishing the trial sections it has generally been past practice to reference the section to station numbers within the contract where the trial is being laid. After a short period of time it is no longer possible to re-locate the stations without resorting to detailed surveying.

For the purpose of this report, each trial which is still active has been visually inspected and sketch plans drawn up which locate the test sections to landmarks on either side of the road. This, it is believed, will be sufficient for personnel who wish to inspect the site in the future to easily locate the sections in the field. It is recommended that, in future, engineers responsible for establishing the trials should prepare sketch plans at the time of construction to eliminate this potential problem. A suggested method of establishing test sections is as follows:

2.1 The test site should be sufficiently long to allow the experimental and control sections to be laid in the same lanes so that they are both subjected to the same traffic loadings. The site should, if possible, be straight and level and without intersections or other features which would subject the pavement to additional, but non-uniform, loadings. Any feature that is likely to impose high accelerating, cornering or braking forces on the experimental sections, unless that is one of the purposes of the trial, should be avoided. Factors that could affect the relative performance of the materials, such as a quarry entrance part way along the intended site, should be carefully considered when selecting the trial location.

2.2 An accurate sketch map of the experimental and control sections should be prepared at the time of construction to precisely locate the trial with respect to surrounding landmarks. These could take the form of buildings or other structures as well as natural features and roadside furniture. Station numbers should also be recorded on the sketches in case it is necessary to relocate the test sections within the contract at some future date.

2.3 Generally, trial sections are too long for an accurate assessment to be made of the material's performance or for measurements to be made on a regular basis at the same locations, which is preferable if the results are to be meaningful. Therefore, it is recommended that monitoring sections be established within each test section. These

should be approximately 100 metres long and typical of the remainder of the test section. They should be located at some distance from the beginning and end of the test section. Their location should also be recorded on the sketch map.

2.4 It would be preferable for signs to be located at the beginning and end of the monitoring sections at the fence line to reinforce the information given on the sketch maps. Some concern over liability has been expressed with regard to this proposal by other Ministry offices. However, a suggested signing regime that could be implemented is given for each of the active sites to mark the transition from one section to another, and to non-experimental materials.

2.5 An initial set of data should be taken immediately following the construction. The type of measurements will depend on the parameters that the trial is intended to improve; for example, if the trial is investigating a proposal to improve mix properties, cores should be taken and analyses made of the binder and the mixture, including Marshall tests, at an early date following construction.

3. Assessments of trial sections

Many of the trials were reported formally in either the EM series or MI series of reports issued by the Engineering Materials Office. The assessment of these trials is referenced to their report number. Other sections were never reported formally and these are referenced by their subject content to the main filing system located in the Downsview office of the Bituminous Section.

The assessments can be divided into 3 parts:

1. A summary of the objectives and findings up to 1988.
2. The results of the 1988 assessment.
3. Recommendations for future work.

Transverse deformation measurements were taken at a number of test sites as a first stage in establishing a material's resistance to permanent deformation. It is intended that measurements should be made over a number of years making it imperative that measurements are made in an identical way on each occasion. A suggested test method was developed and this is presented as Appendix 1 to this report.

3.1 Report number EM 8

Report name Dense mastic surfacing of an orthotropic, bascule bridge.

Date 1975

Author R C Evers

Summary

Contract 73-125. The Indian River Bridge at Port Carling was originally surfaced with asphaltic concrete. The first raising of the bridge resulted in more than 50 per cent of the surfacing sliding from the deck. Bemac Protective Coatings designed and constructed a mastic surfacing to replace the original. The preparation and construction of the new surfacing is described in the report.

Site Inspection

The bridge was inspected on 28th June 1988. The mastic surfacing had cracked over every W-shaped strap plate and these had been extensively routed and sealed. Longitudinal and transverse cracks were now appearing between the line of the strap plates and the sealant was also beginning to crack.

Chip retention was very good but the rate of spread of the chippings was obviously variable and generally insufficient. Virtually all the texture depth had been lost, particularly in the wheel paths, as the chippings had been punched into the mastic by traffic action.

In one location a small area of the steel mesh measuring approximately 125 x 50 mm is visible from the surface. This may have been caused by the action of snow plows but it is thought more likely that there was insufficient depth of cover at the time of construction. The mastic is laid entirely by hand and the quality of the finished product is therefore very dependent on the skill and the eye of the operatives.

Proposal for Further Work

1. No further assessments are required. The material provides a very durable surfacing which is performing adequately after 15 years.

2. It is recommended that the cracks be resealed to ensure the excellent waterproofing properties of this material are maintained.

3. Consideration should be given to chip sealing this surfacing. This will not only restore the surface texture and hence skid resistance of the deck but will also seal some of the low severity cracks, of which there are many.

4. If similar materials are to be used in the future, consideration should be given to modifying the mix. For example, the use of a harder binder would reduce the possibility of the chippings being punched into the mastic and the texture being lost. A higher binder content in a finer graded mix may also improve the material's resistance to cracking.

3.2 Report number EM 9

Report name: Evaluation of anti-stripping additives for asphaltic concrete mixes
Effectiveness and recommended usage.

Date: July 1977

Author: F Field

Summary

For many years the stripping of asphalt cement from aggregate particles has been of concern to the Ministry. Various steps have been taken to alleviate the problem, one of which is to add anti-stripping additives to the asphaltic concrete mixture. The report discusses some of the principle causes of stripping such as poorly dried aggregate; aggregate type; the presence of free water, salt and high void contents; stockpile age; dust coated aggregate; viscosity of asphalt; excess of anti-stripping additive. Some of the laboratory test procedures available to assess the stripping potential of mixes are discussed and the effectiveness of anti-stripping additives used on 11 contracts where the aggregate, Jamieson, was known to have a poor stripping performance was investigated.

Recommendations of report EM 9

The report gives recommendations regarding the usage of anti-stripping agents which can be summarized as follows:

1. Sand-asphalt layers do not need an additive.

2. Binder courses require additives when laid on granular bases with poor drainage performance. Where the granular base has good drainage characteristics and a low water table or if the construction is on an old concrete or sound bituminous pavement, additives are not necessary.

3. Surface courses laid in a single lift on a granular base may require anti-stripping additives but the decision will depend on drainage conditions and pavement voids.

4. For multiple lift pavements additives should be considered if the pavement void content exceeds 6 per cent, with the exception

of open graded mixes. If the paving is to take place late in the year, compaction is likely to be reduced leading to a higher void content.

5. Where the sand content in a surface course mix exceeds 55 per cent the surface is likely to have an excess of fines and asphalt due to their migration during compaction making the surface virtually impermeable. It is recommended that, under these conditions, a pavement void content of 7 per cent could be tolerated before an anti-stripping additive becomes necessary.

Proposals for further work

No further work is required.

3.3 Report number EM 16

Report name Bridge waterproofing combining form-in-place and preformed sheet systems.

Date 1977

Author R C Evers

Summary

Contract 76-430 called for the replacement of a railway bridge in the Town of Timmins, the construction taking place in two halves so as to maintain rail traffic at all stages of the construction. At the completion of the first half of the new structure, the specified waterproofing membrane, a butyl sheeting, was unavailable. The waterproofing sub-contractor was granted approval to use an alternative system using a hot-poured rubberized asphalt form-in-place method as a bonding agent for a thinner than specified butyl sheet.

The report discusses the construction procedures adopted on the project.

Conclusions of report EM 16

1. A major problem with any sheet waterproofing system is that it is virtually impossible not to trap air under the sheet. Puncturing of the sheet to remove the pockets of air require patching. Using the hot rubberized asphalt as the bonding agent eliminates this problem as the punctured sheet can be pressed down until some of the rubberized asphalt extrudes through the hole, thus resealing it.

2. The seams in the butyl sheet could have been formed in a similar way to that described above and an improved job would have possibly resulted as well as great savings in time and labour.

3. The thickness of the form-in-place method tends to be very variable while the preformed sheet system is laid at a constant thickness. This confidence in the latter method outweighs its disadvantages of being labour intensive and liable to trapping air.

4. The installation served to illustrate how the two methods could be married to provide a very effective systems.

Proposals for further work

No further work is required on this project.

3.4 Report number EM 56

Report name Hot Mix Recycling - 1980

Date September 1981

Author R C Evers

Summary

In 1979, the Ministry adopted hot-mix recycling as a standard pavement rehabilitation alternative. This decision led to the tendering of over 726,000 tonnes of recycled hot-mix on 22 contracts during 1979 and 1980 and to a special provision being placed in all hot-mix contracts allowing the contractor the option of using up to 25 per cent reclaimed material in binder course mixes. Three contracts were selected for detailed data gathering and the individual project reports are appended to the main report. The three projects were Contract 80-28 on Highway 29 at Smith's Falls; Contract 79-105 on Highway 69 at Parry Sound; and Contract 80-202 on Highway 17 at Warren.

Observations and Conclusions

A very large number of observations and conclusions were made as a result of this investigation, some of the more notable ones being as follows:

1. Cold planing significantly reduces the stone content and increases the passing 75 µm.

2. Contamination of recycled mixes can occur due to poor stockpiling and handling methods.

3. Partial depth reclaiming yields higher A.C. content due to lower contamination than the rip, haul and crush operation.

4. Batch plants are capable of recycling at ratios of 50:50, while drum mix plants are capable of handling 70:30 mixes.

5. Higher Marshall stability and flow values were achieved with recycled mixes.

6. Appropriate action is required in order to achieve better mix control of recycled mixes.

7. Machine placing of recycled mixes is comparable to virgin mixes.

8. Hand work with recycled mix can be expected to be more difficult than with a virgin mix.

9. Compaction of recycled mix is comparable to that of a virgin mix.

Proposals for further work

No further work is required.

3.5 Report number M' 26

Report name Evaluation of emulsion primers.

Date January 1981

Author R C Aquin

Summary

Assesses the potential of Prem 961 marketed by McAsphalt Industries as an alternative to RC-30 o: MTC Primer. Describes the performance of Prem 961 at 8 sites. Prem 961 is an emulsion primer while current primers are cut-back liquid bitumens containing a high proportion of costly petroleum solvent.

Observations

1. Prem 961 forms a hard surface when cured.

2. When hard surface is formed on soft grade, Prem 961 cracks resulting in loss of the primed surface.

3. Penetration of Prem 961 into granular base is significantly less than MTC Primer and Chevron SP-6.

Recommendations

It is recommended that Prem 961 is not accepted as an approved alternative to current practice.

Proposals for further work

No further work is required.

3.6 Report number MI 27

Report name Evaluation of crack sealing compounds for asphaltic pavements.

Date December 1980

Author R C Evers

Summary

It was recognized that more pavement maintenance and less new or reconstruction of the existing road network would become the norm during the economic downturn of the 1980's. This necessitated that the Ministry identify materials suitable for the sealing of cracks in bituminous pavements as part of the maintenance operations. The materials then being used by the Ministry for sealing asphalt pavement cracks were originally identified as suitable for sealing Portland cement concrete pavement joints and may or may not be suitable for use with asphalt.

This report covers the background and construction of a trial on Highway 69, between Port Severn in the south and MacTier in the north, in which 13 crack sealing products were installed in an asphalt pavement. Observations and conclusions on construction techniques, efficiency and effectiveness of this maintenance operation are also presented.

Evaluation of the various sealants and recommendations were to be the subject of subsequent appraisals to be reported annually.

Conclusions of report MI 27

A number of conclusions were drawn from the trials with regard to equipment, construction methods and materials, as follows:

1. Careful inspection of routing work will be required if all cracks are to be treated.

2. Routing and sealing work should not be undertaken if the cracks are showing signs of dampness.

3. Only back pack blowers in first class operating condition were successful in cleaning routed grooves.

4. Air blowing of the routed grooves should immediately precede the filling operation.

5. Cold pour sealants are not suitable for use where they would be subject to traffic less than 2 h after installation. Emulsion based sealants should not be placed if rain is forecast in the next 12 h.

Proposals for future work

No further work is required on this site due to the age of the sealants.

3.7 Report number MI 60

Report name: Double surface treatment without prime versus Prime and single surface treatment

Date: January 1984

Authors: J A Cooper and R C Aquin

Summary

With the cost of liquid asphalt soaring, the application of prime to granular bases is becoming very expensive. This trial was designed to investigate whether the same performance could be achieved using cheaper materials in the double surface treatment system.

Several sections of DST were laid and the following benefits were anticipated: cost savings; equivalent or better performance than prime and single surface treatment; savings in time as fewer moves onto and off the site are required; prime can be lost due to rain or damaged during the curing period; energy savings as prime contains some 50 per cent solvent.

Conclusions of report MI 60

1. High Float emulsions perform well in this application. Other emulsions are not recommended.

2. Class 2 aggregates can be used satisfactorily.

3. The base should be hard packed granular material with little loose float.

4. Cost savings in excess of 14 per cent can be expected.

Recommendations of report MI 60

1. The performance of the trial sections should continue to be monitored.

2. Districts should construct several sites of DST with P&SST controls nearby.

3. Bituminous section should report findings of the 1983 work.

4. If second trial proves satisfactory, consideration should be given to including DST as an alternative to P&SST.

Proposals for further work

No further work is required on this project with the removal of the financial incentives.

3.8 Report number MI 74

Report name: Tensar Geogrid test section - Highway 59 (Also earlier site on Highway 5).

Date: 1986

Authors: R F McLuckie
P Korgemagi
D F Lynch

Summary

A pavement reinforcement test section using Tensar AR-1 Geogrid was installed on Highway 59 south of RR45. The purpose of the trial was to see whether it was possible to place Tensar on an existing asphalt roadway and to determine whether Tensar reduces crack reflection and resists permanent deformation. (The previous trial on Highway 5 west of Guelph Line with Tensar between the lower and middle binder courses indicated several problems with both the installation and performance of Tensar). Three sections were laid; 1 of 50 mm overlay as the control, 1 of 50 mm overlay with emulsion and chip seal, and 1 of 50 mm overlay, Geogrid and emulsion and chip seal. An inspection of the sections after 2 winters service was also carried out.

Conclusions of Report MI 74

1. It is possible to lay Tensar Geogrid on an existing pavement using a surface treatment process.

2. The Tensar Corporation have made good progress in removing many of the deficiencies in production.

3. The Tensar test section on the north bound lane has more pavement edge cracking than either of the control sections.

4. It was too early for any conclusions to be drawn regarding the crack retarding and structural enhancing capabilities of Tensar.

Site Inspections

The two sites were inspected on 7th April 1988.

Highway 5

The site on Highway 5 exhibited extensive cracking in both lanes. There was no obvious difference between the test section and the adjacent material which acted as control.

Crack mapping was carried out on this site on 14th June 1988. From the crack survey it is noticeable that the Tensar section has less cracking than the selected control section but that the degree of cracking is very high in both cases. In addition to the major cracks, the surface of the pavement was covered with innumerable short (200-300 mm) and fine (1-2 mm) cracks typically at 300 mm centres and mainly transverse. The surfacing is a DFC using steel slag coarse and fine aggregates and this type of cracking has been seen elsewhere in association with steel slag aggregates - notably on Highways 6 and 55 in modified HL-3 mixes. The surfacing on this contract was designed to have 45 per cent coarse aggregate and 5.6 per cent asphalt cement content. The steel slag came from Stelco. It would appear that, despite the installation problems, the Tensar is having some positive effect in reducing the amount of cracking. However the degree of cracking is very high for reasons that may not be associated with the Tensar trial.

Highway 59

The Highway 59 site was in good condition. All sections exhibited small, local amounts of flushing. Cracking was restricted to the edges of the 50 mm control overlay. Recycled material incorporating RA-75 super-soft AC had been used in the overlay on the entire contract which may, by itself, be retarding the cracking process.

On site testing was carried out in the south bound lane on 14th June 1988. Crack mapping confirmed the earlier visual inspection that there was some edge cracking in the control section and one transverse crack at the north end of the Tensar test section, extending across the centre of the lane but not to the wheel paths. Again, the RA-75 asphalt cement may be allowing the traffic to heal this crack which might otherwise be developing right across the pavement.

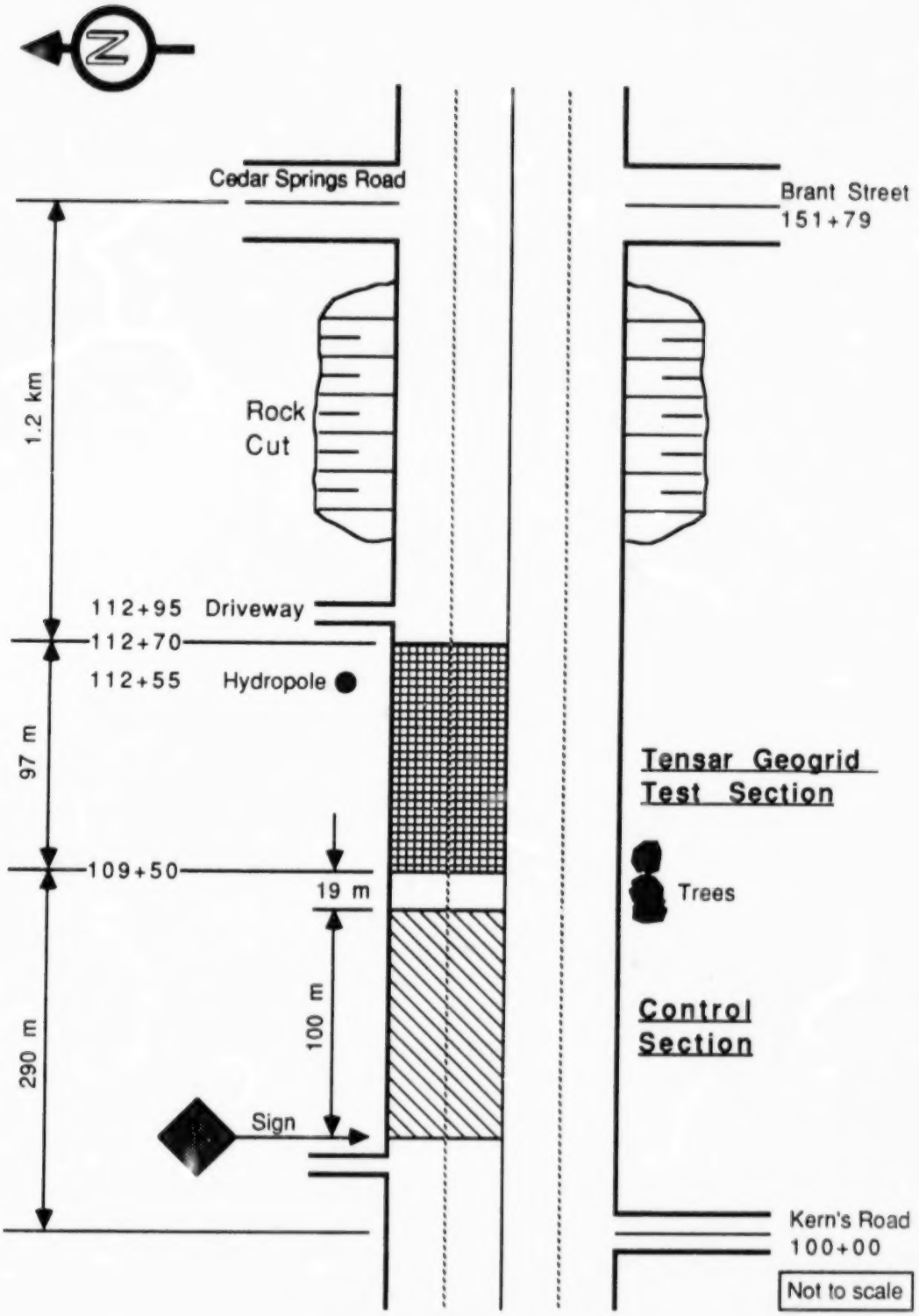
Transverse deformation measurements indicated some 4 mm variation in height between the centre of the lane and the wheel paths. The variation was very similar in all three sections, with the greatest differences in the Tensar test section. In the early life of the pavement, this may be due more to compaction by traffic closing up voids and may not be sustained. Longer term monitoring will help to confirm this. The relative height variations are considered to be small. The deformations were measured with an aluminum beam at 10 m intervals along the trial, starting from 5 m inside each section to ensure that the transition zone from one section to another was avoided. The 10 sets of measurements were averaged to produce the cross sectional plots (see Appendix 1).

Proposals for future work

1. The Highway 5 site can be largely abandoned, although it is suggested that the crack mapping be repeated in, say, 4-5 years time to confirm whether the crack reducing benefits of Tensar have continued. The site should certainly be revisited prior to any reconstruction taking place.

2. The Highway 59 site, where the installation technique appeared to work quite well, should be monitored more closely with crack mapping and transverse deformation measurements carried out on an annual basis for the next few years. It would appear that the use of RA-75 super-soft asphalt cement is retarding the cracking process and this, coupled with the very light traffic loadings on this road (2000 AADT in 1986), means that any advantages in using Tensar to reduce cracking and resist deformation will take much longer to become apparent.

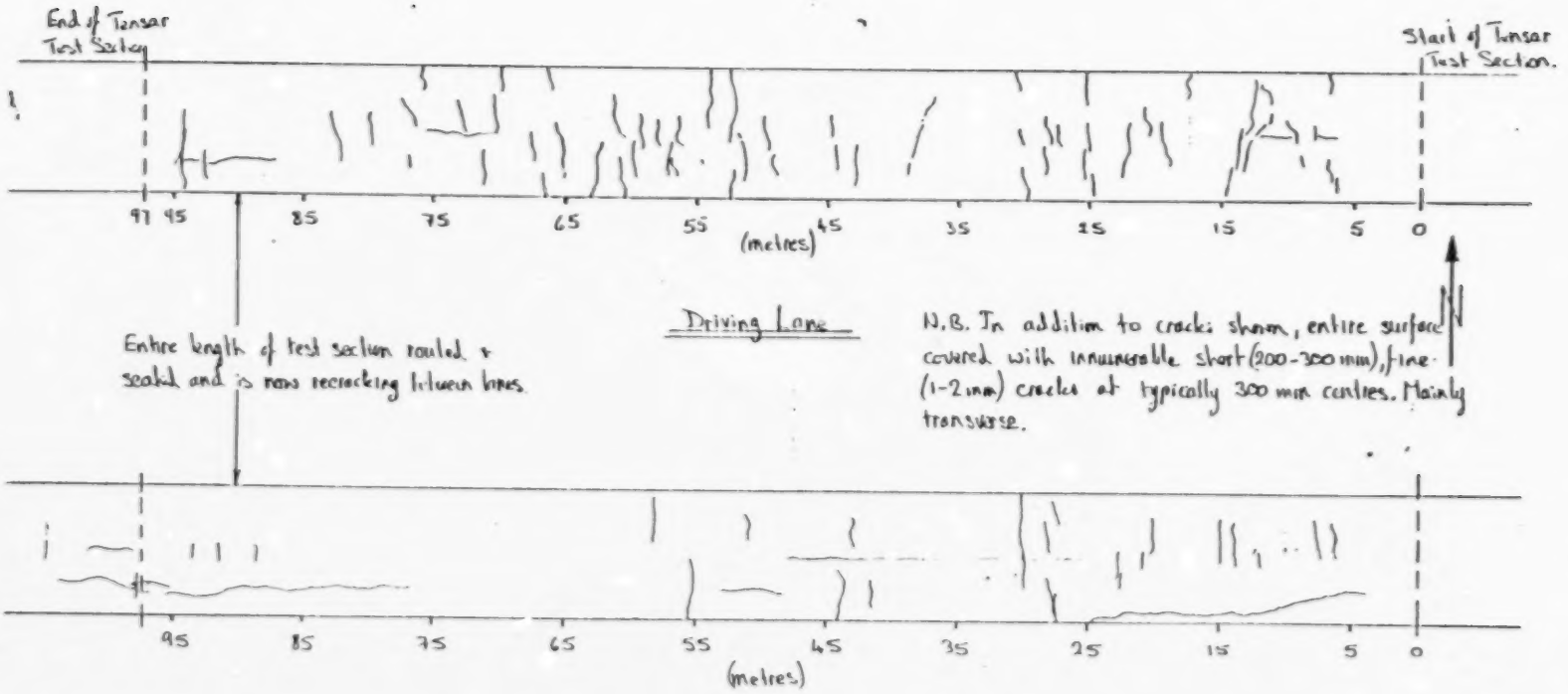
3. Tensar is a very costly material to install and the benefits accruing from its use would have to be considerable to warrant the expenditure.



Tensar Geogrid Paving Trial - Highway 5 near Burlington

11th June '88

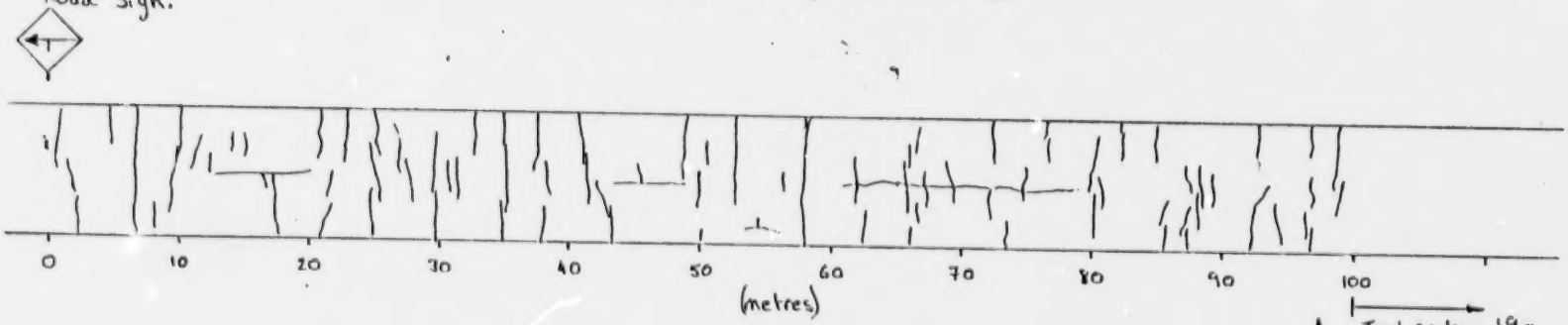
Highway 5 - Tensar Geogrid Trial


End of Tensar Test Section
Start of Tensar Test Section.
97 95 85 75 65 55 45 35 25 15 5 0
(metres)
Driving Lane
Entire length of test section rolled + sealed and is now recracking between lines
N.B. In addition to cracks shown, entire surface covered with innumerable short (200-300 mm), fine (1-2 mm) cracks at typically 300 mm centres. Mainly transverse.
95 85 75 65 55 45 35 25 15 5 0
(metres)
Passing Lane.

14th June '88

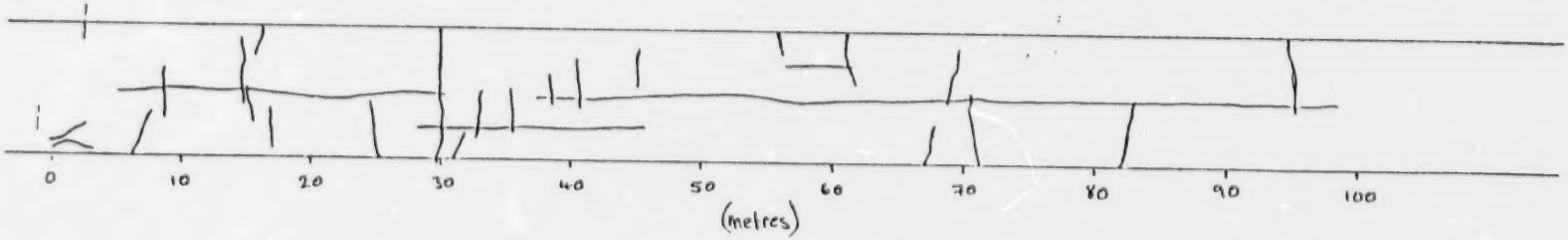
Highway 5 - Control Section

Road Sign.

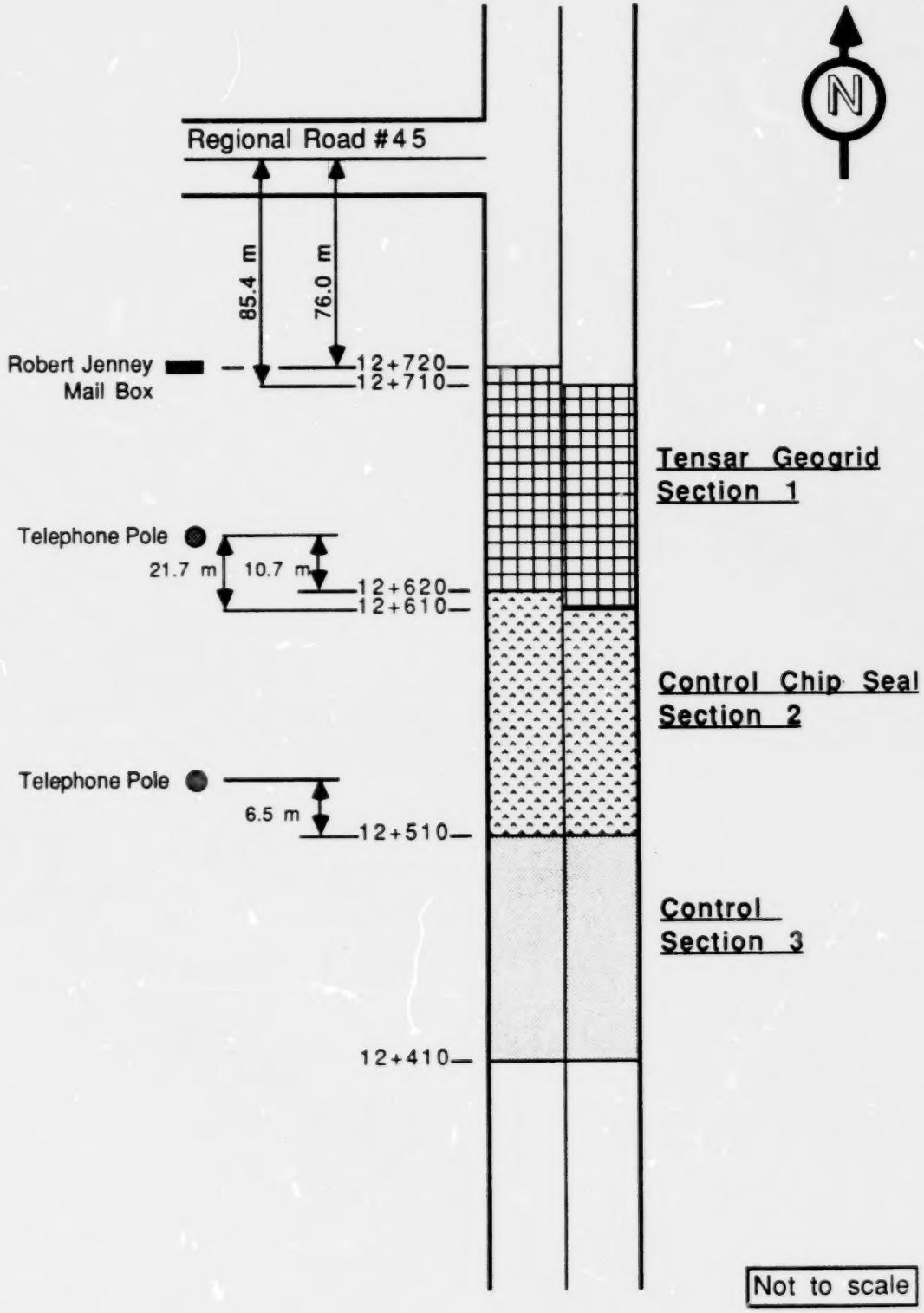


N.B. Additionally, entire surface covered with innumerable cracks. Mainly transverse and typically at 300 mm centres, the cracks are generally short (200-300 mm) and fine (1-2 mm).

Driving Lane



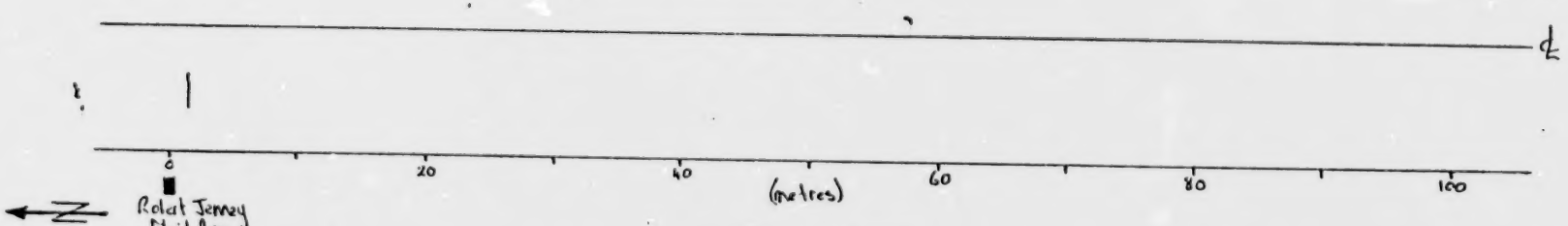
Passing Lane



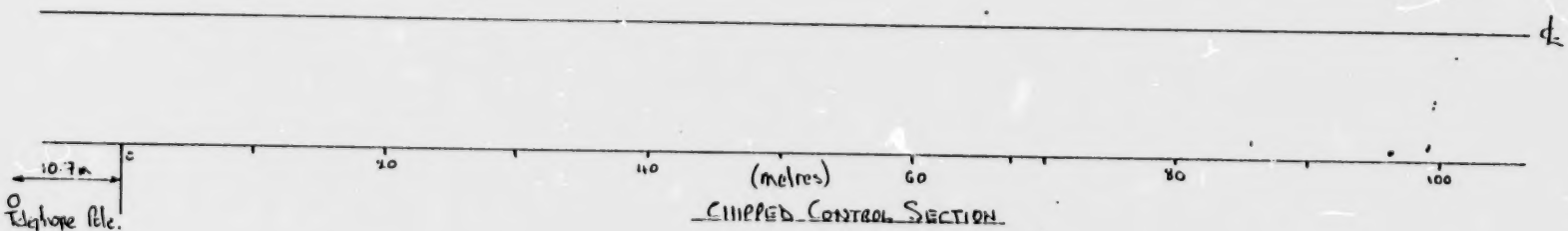
Tensar Geogrid Paving Trial - Highway 59 near Port Rowan

14th June '88

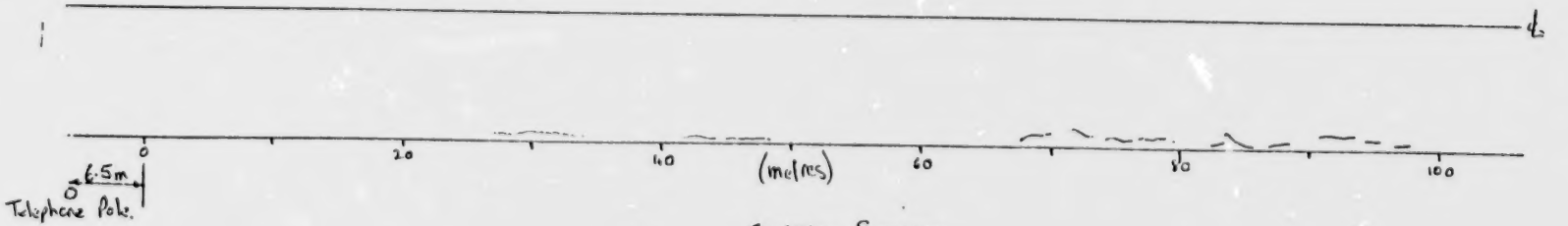
Highway 59 - Tensar Test Sections
South Bound Lanes



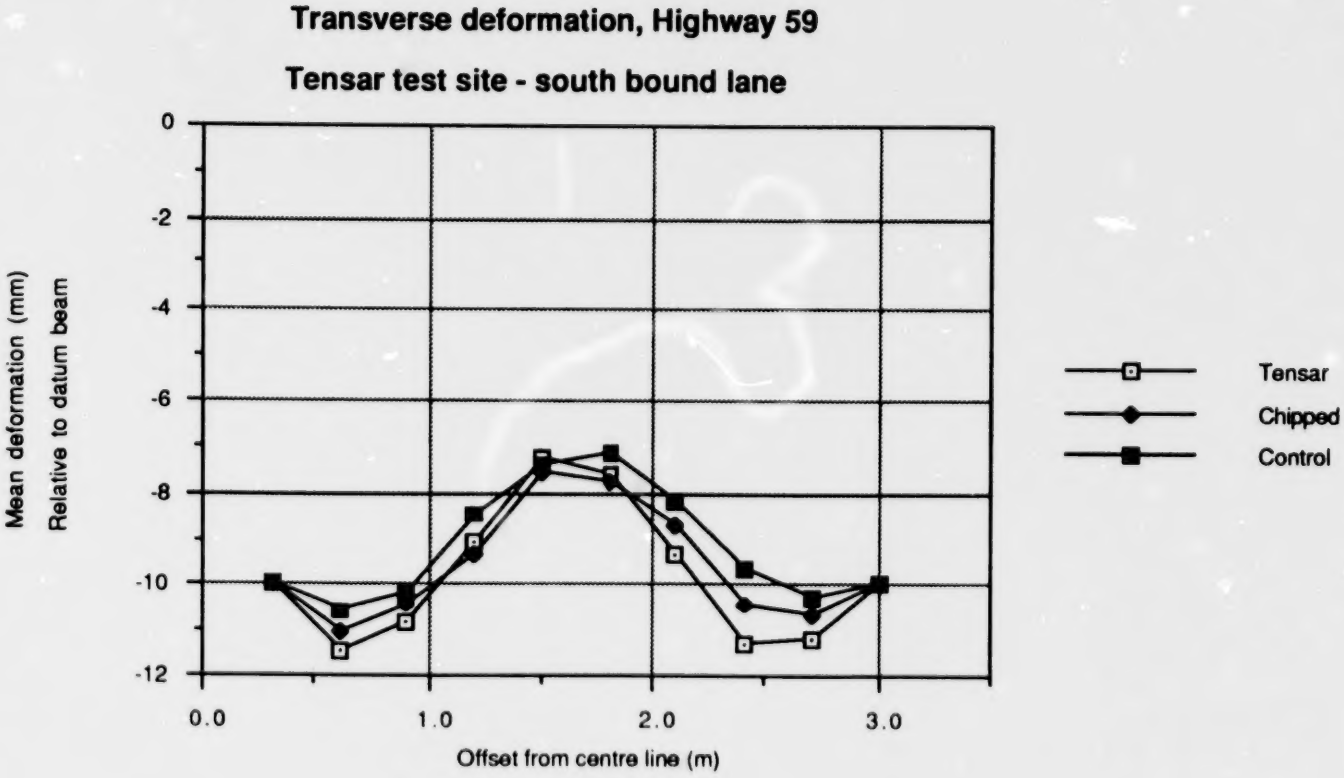
Tensar Section

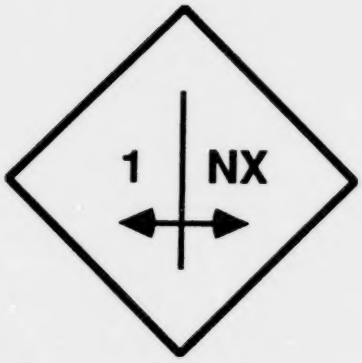


Clipped Control Section

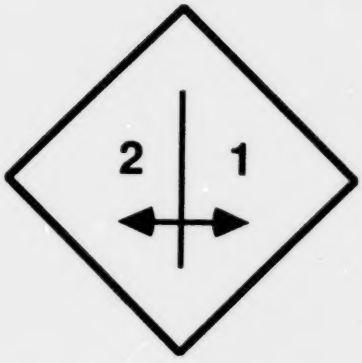


Control Section

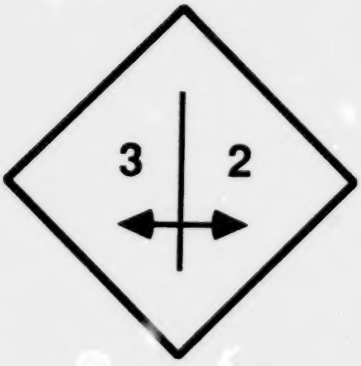

Transverse deformation, Highway 59
Tensar test site - south bound lane
Mean deformation (mm)
Relative to datum beam
0
-2
-4
-6
-8
-10
-12
0.0
1.0
2.0
3.0
Offset from centre line (m)
Tensar
Chipped
Control



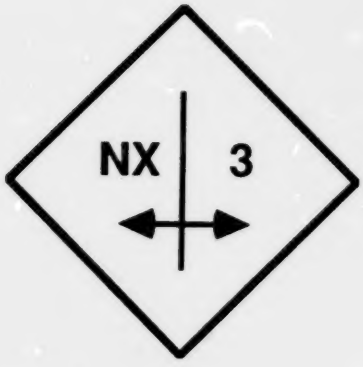
Sign 1



Sign 2



Sign 3



Sign 4

Proposed Signing
Tensar Geogrid Test Section - Highway 59

3.9 Report number MI 103

Report name: An evaluation of a triple-jointed-screed paver as a solution to pavement rutting.

Date: January 1987

Authors: S A Bulger
P Korgemagi
D F Lynch

Summary

In order to counteract pavement deformation along the wheel paths, Dynapac introduced a triple-jointed-screed paving system. The 4-part articulated screed places a mat with a positive crown set over each wheel path. The extra material in the crowns is rolled flat by the rolling train. Increased compaction in the wheel paths should result in an increased resistance to permanent deformation.

EMO constructed a trial section using the triple-jointed-screed paver on Highway 401 east of Port Hope as part of Contract 85-69 in the summer of 1986. Close monitoring of the two trial sections and a control section laid with conventional equipment will assess the effectiveness of the technique.

Conclusions of report MI 103

1. The joint adjustment system on the triple-jointed-screed paver needs improvement to make it easier to work with. The present 'trial and error' method is far too slow and cumbersome.

2. The triple-jointed-screed paver laid an acceptable quality mat.

3. The 7 mm crowns placed over the wheel-paths were rolled virtually flat.

4. The resulting pavement had lower compaction in the centre of the lane. 1 per cent higher compaction was achieved in the wheel paths than in the oil lanes.

5. Major cost increases of using the modified paver were rental costs and downtime spent in familiarizing the paving gang with the new equipment.

6. Differences in average per cent compaction between test and control areas may be due, at least in part, to fundamental differences between European and North American machines.

Recommendations of report MI 103

1. Performance of the test areas to be monitored - including profile surveys.

2. A test area using the Dynapac paver with no crown set over the wheel paths should be laid as a less variable control section.

3. The crown adjustment procedure must be improved before any further work is undertaken.

Site Inspection

The site was inspected and on-site testing carried out on 19th July 1988. The sections can be located by signs placed at the fence line at the time of construction. A transverse profile survey was made of the three sections and the results are given on the attached sheets.

Section B1

Section B1 is the control section laid with conventional equipment. The surfacing was seen to be tight with some local patches of flushing approximately half way along the section. There had been some very slight ravelling adjacent to the centre line joint where the new material meets the original material of the passing lane. The passing lane was not repaved at the same time as the driving lane.

Transverse cracking was observed to coincide with cracks in the older material of the passing lane. Some of the cracks extended right across the lane while others were only part way across, starting from the centre line. They were assumed to be reflection cracks and are therefore not significant in the evaluation of the experimental equipment. There were no longitudinal cracks in this section.

Section B2

Section B2 was milled and 40 mm replaced using the triple-jointed-screed paver. The section did not appear to be as rich as Section B1 and was estimated to have generally a higher texture depth. This is surprising as the analyses of the materials at the time of

construction did not indicate significant differences between the mixes in the different sections.

The surfacing was much more open at the centre and at the edges of the lane with some ravelling. This agrees with the compaction test results carried out at the time of construction when the centre of the lane was found to have a much lower degree of compaction (96.9 per cent) than in the wheel paths (100 per cent) and may have some significance on the long term durability of pavements laid with the experimental equipment.

Transverse cracking was seen to be very similar to that seen in Section B1, coinciding with cracks in the original pavement of the passing lane with some cracks extending across the full width of the lane and others only reaching part way. No longitudinal cracking was observed.

The section was laid on a slight right hand curve which has had the effect of pushing the wheel paths towards the shoulder of the road as drivers tend to hug the inside line. This will have an affect on the appearance of the deformation profiles.

Section B3

Section B3 had a 40 mm overlay placed by the triple-jointed-screed paver and was very similar in appearance to Section B2. The transition between the two sections was very difficult to distinguish. This section was also laid on the gentle right hand curve which will affect the appearance of the deformation profiles.

The centre of the lane is generally less tight than in the wheel paths and is associated with slight coarse aggregate loss. As in Section B2, this agrees with the results of the compaction tests carried out at the time of construction when the centre of the lane was found to have a lower degree of compaction (97.8 per cent) than the wheel paths (100 per cent). The differences are not so great as in Section B2 because the presence of the wheel ruts, which were not removed by milling prior to repaving, has reduced the effective height of the crowns placed by the experimental paver.

Low severity transverse cracks were observed at the eastern end of the section and a longitudinal crack has opened up for approximately 10 per cent of the section length at the centre line.

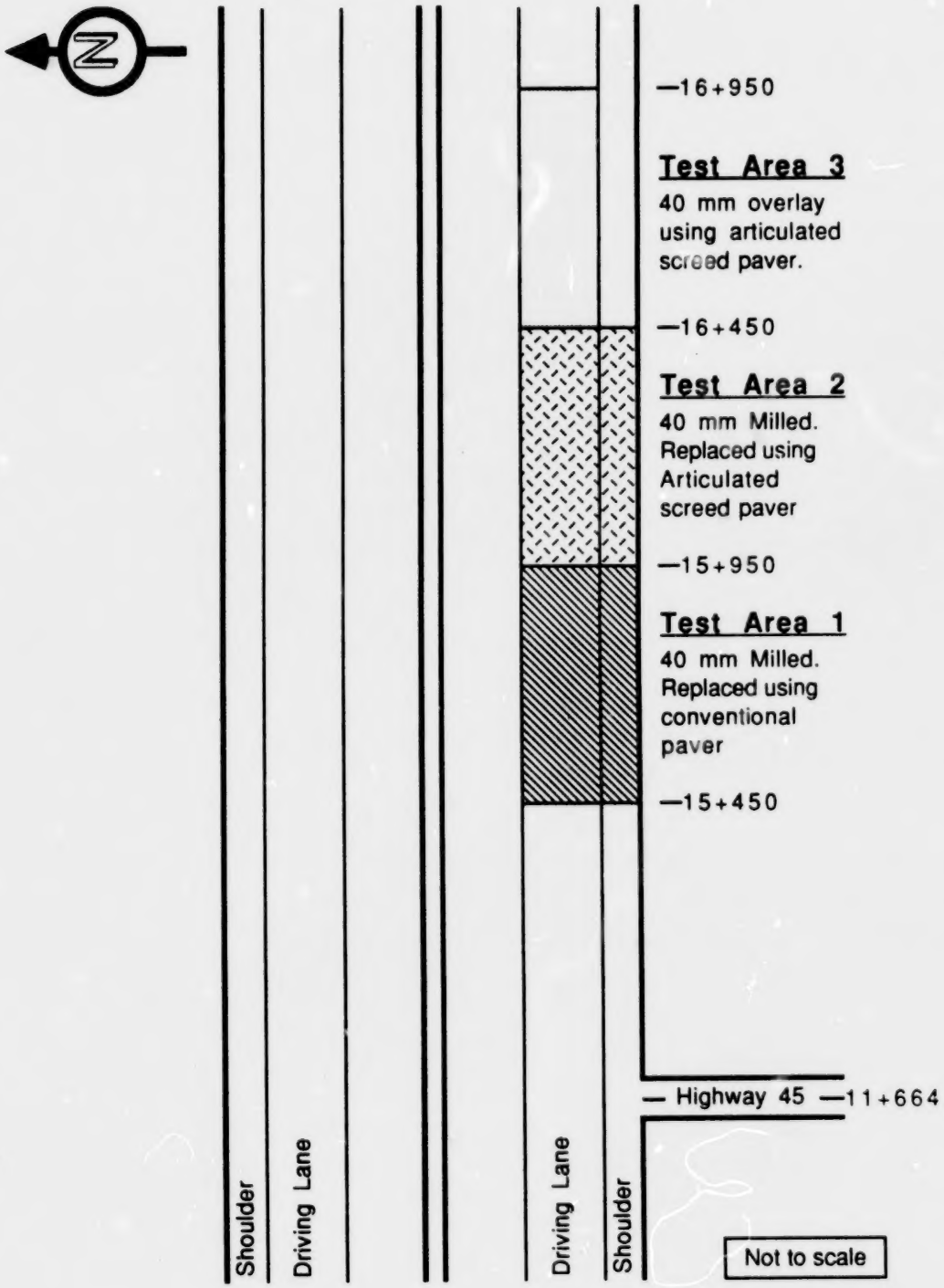
Conclusions

1. The transverse deformation profiles carried out to date are not conclusive in proving the effectiveness of the triple-jointed-screed paver as a means of reducing pavement rutting. The material placed by the conventional equipment appears to be performing as well if not better than the material in the other two sections, with less than a 5 mm total variation between the high and low points of the cross section. This compares with approximately 8 mm for the other two sections although it must be remembered that they were constructed with a greater initial variation than Section B1. The rich appearance of the material in Section B1 would suggest that it would have a lower resistance to permanent deformation than the other two sections but this does not appear to be the case.

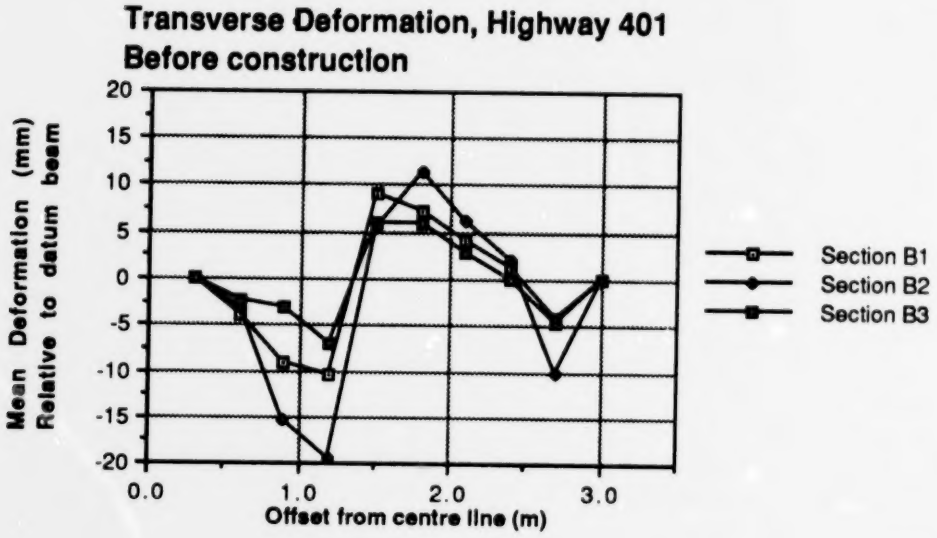
2. The relative openness of the material at the centre and edges of the lanes in Sections B2 and B3 gives cause for concern. It would appear that, where the roller was compacting the crowns placed over the wheel tracks, it has bridged the remainder of the mat producing a lower level of compaction. This in turn has had a detrimental affect on the performance of the pavement which may give rise to premature failure of the surfacing and the need for earlier remedial measures to be taken.

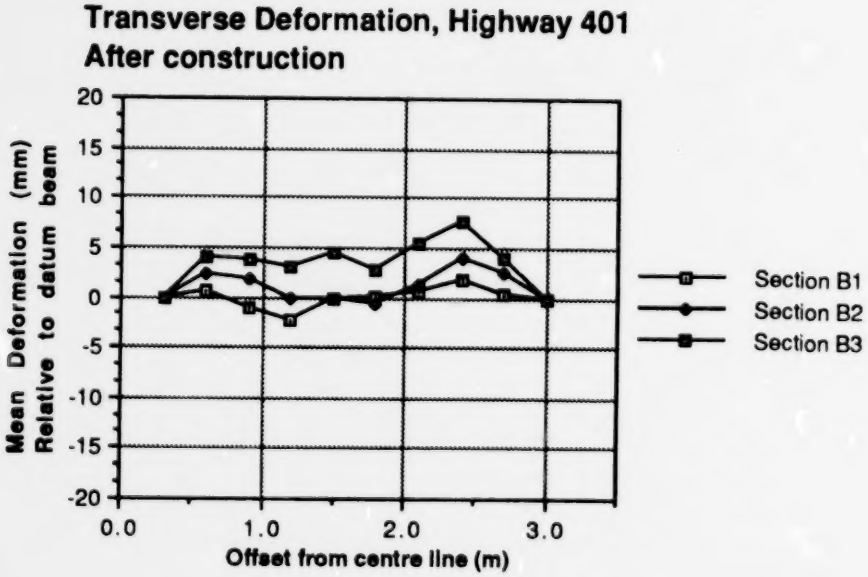
3. It is unfortunate that the experimental sections were laid on a site which is not straight, as the traffic is no longer truly channelized. There is inevitably more variation in the vehicle paths around a curve than along a straight line. Any further assessment of the equipment should take this into account. This also has a bearing on the use of the experimental machine as it is designed to place a crown where the wheel paths would normally be. If the wheel paths are no longer symmetrical about the centre of the lane it would seem necessary to displace the position of the crowns to compensate, involving some complicated control and design procedures.

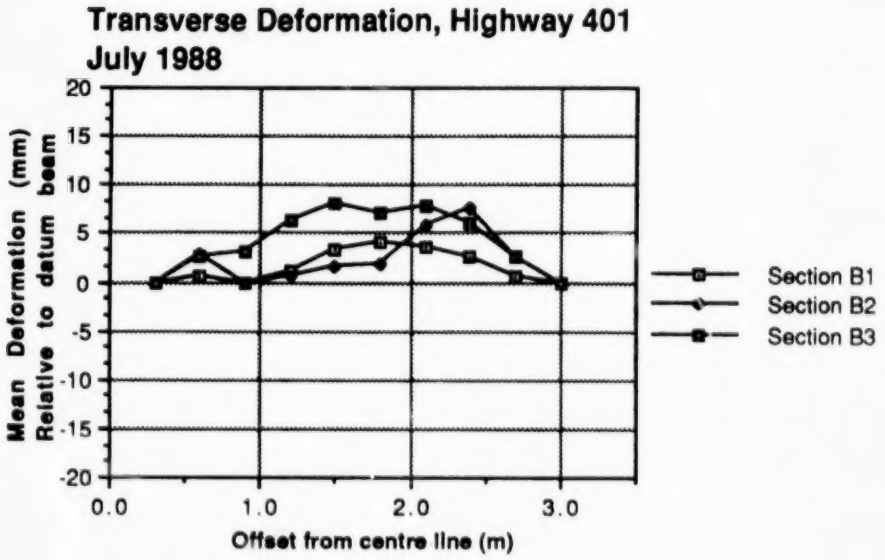
4. The trial site should continue to be monitored to fully evaluate the performance of the triple-jointed-screed paver. Transverse deformation surveys should be undertaken annually for the next few years and, if the openness of the centre and edges of the lane worsens, permeability measurements should be made so that early remedial measures can be taken.



Tripie-jointed screed paver - Highway 401 near Cobourg


Transverse Deformation, Highway 401
Before construction
Mean Deformation (mm)
Relative to datum beam
20
15
10
5
0
-5
-10
-15
-20
0.0
1.0
2.0
3.0
Offset from centre line (m)
Section B1
Section B2
Section B3


Transverse Deformation, Highway 401
After construction
Mean Deformation (mm)
Relative to datum beam
20
15
10
5
0
-5
-10
-15
-20
0.0
1.0
2.0
3.0
Offset from centre line (m)
Section B1
Section B2
Section B3


Transverse Deformation, Highway 401
July 1988
Mean Deformation (mm)
Relative to datum beam
20
15
10
5
0
-5
-10
-15
-20
0.0
1.0
2.0
3.0
Offset from centre line (m)
Section B1
Section B2
Section B3

4. Conclusions

4.1. It is imperative that the long term assessment of test sections be considered when establishing trial sites. The selection of the site, together with the making of accurate records of its location, are essential factors in enabling the best possible information to be obtained from the experiment. The cost of these trials can be significant and it is therefore most important to make the best use possible of the investment of public funds. It is also important to ensure that new materials and methods are fully assessed in the fairest possible way. A method for establishing test sites has been suggested.

4.2. Most of the sites reviewed in this report can be abandoned by the Bituminous Section. Further assessment is required as follows:

4.2.1. Highway 5
The early Tensar Geogrid test site near Burlington should be reinspected in 4 to 5 years time. Crack mapping should be carried out again at the time of the inspection.

4.2.2. Highway 59
The Tensar Geogrid test site should be assessed annually for the next few years. Crack mapping and transverse deformation measurements should also be continued.

4.2.3. Highway 401
The triple-jointed-screed paver was used east of Port Hope. Annual inspections and measurements of transverse deformations should continue. It may become necessary to perform permeability tests in the near future.

APPENDIX 1

Method of measuring Transverse deformations of pavements

Introduction

The resistance of a pavement to permanent deformation is an essential requirement of bituminous mixes and any attempt to increase a material's resistance is well worth while. To monitor this aspect of the performance of experimental Test Sections it is necessary to specify exactly how the testing is to be conducted so that materials can be compared relative to each other and their performance monitored from year to year. One means of measuring the resistance of a material to permanent deformation is to monitor the development of ruts in the wheel paths of the pavement by means of a datum beam laid at right angles to the direction of flow of the traffic. The Quality Assurance Office of the Central Region produced some guidelines for "Template Surveys" in 1977 and these have been used as the basis of this test method.

Equipment

The equipment required to carry out the test consists of the following:

1. Aluminum datum beam at least 4 m long graduated at 0.1 m intervals along one side.

2. Measuring wedge with a slope of 1:10, giving a readable accuracy of ± 0.1 mm and graduated along the top face to make it readable from above.

3. Elevating blocks to raise the datum beam above the surface of the pavement. Unless the degree of rutting is severe, 15 mm high blocks have been found to work satisfactorily.

4. Road paint to mark the edge of the pavement.

5. Measuring wheel or tape.

Preparation of Test Sections

The location of each Test Section should be carefully documented and detailed sketch plans made of the sections, related to local landmarks. The Test Sections are typically too long to allow for detailed assessments to be made. For this reason Monitoring Sections should be established within each Test Section and, if possible, signs placed at the fence line to indicate their beginning and end. The location of the Monitoring Sections within the Test Sections should also be fully recorded on the sketch plans. Monitoring Sections should be typically 100-150 m long.

Using the measuring wheel and road paint, 10 or more Test Stations can be marked off along the Monitoring Section. The end stations should not be less than 5 m from the ends of the Monitoring Section to ensure that any transition zone from a different material is avoided. Positioning test stations at 10 m intervals along the monitoring section is convenient.

Test Method

The datum beam is set up at the first station on the two elevating blocks (see Fig. 1). One block is placed adjacent to but not on the painted centre line marking the edge of the lane. The second block should be placed at least 150 mm in from the edge of the pavement in order to avoid edge distortions and irregularities. The measuring wedge is then slid between the beam and the pavement surface and the vertical distance recorded. This procedure is followed at several points along the beam (or 'offsets' from the centre line), always starting at the centre line and working towards the shoulder. The number of measurement points is at the discretion of the operator, but 300 mm intervals have been found to be convenient.

Each station along the monitoring section is tested in the same way, with measurements taken at the same offset positions at each station, so that the final data set will consist of 10 or more sets of readings at a number of points (or offsets) across the roadway.

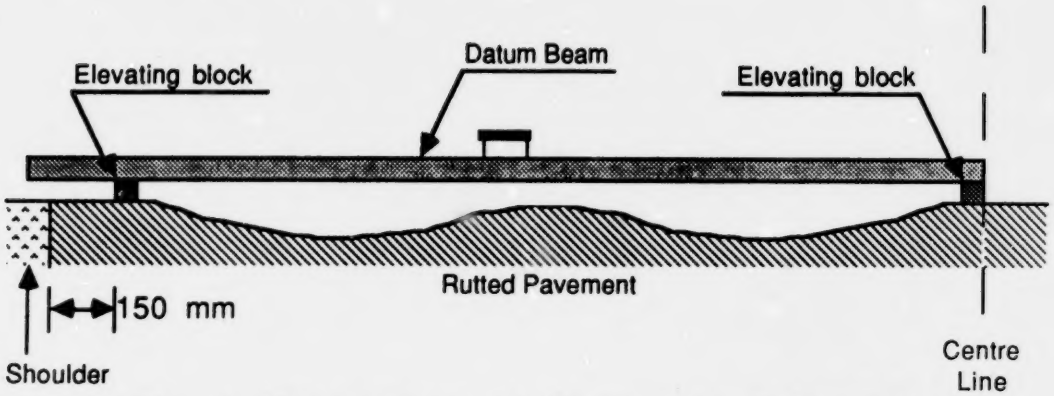


Fig. 1 Measurement of Transverse Deformation

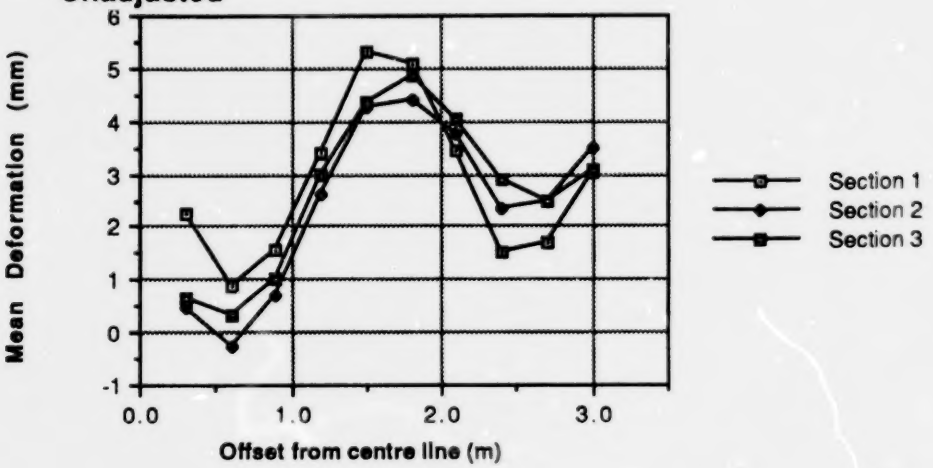
Analysis of Results

The data must be presented in a consistent way such that comparisons can be made between two materials. This is necessarily a subjective process but it is possible to remove some of the subjectivity by careful presentation of the data. It is helpful to plot the results of a number of Monitoring Sections which are to be compared on the same graph.

1) The data set is first inspected to ensure that there are no outliers or obvious errors in recording the data.

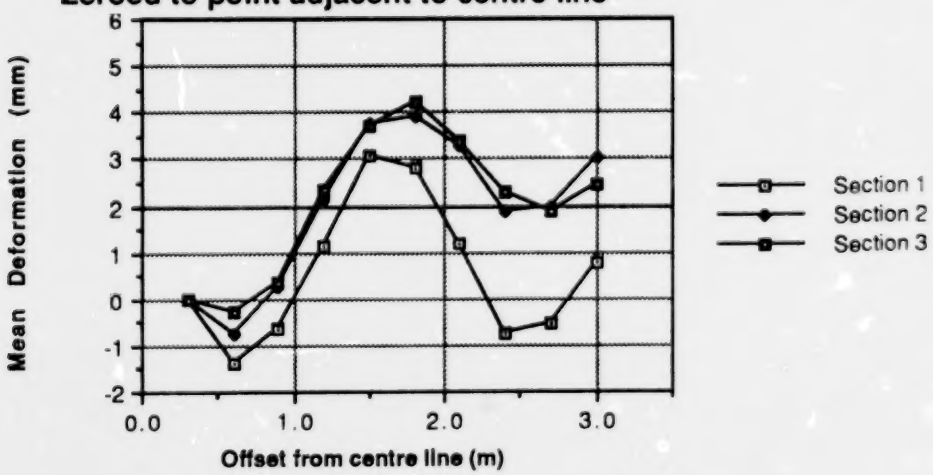
2) The measurements made at each offset position across the width of the pavement are averaged. Graph 1 is an example of what the resulting plots would look like.

Graph 1 - Mean Transverse Deformation Unadjusted



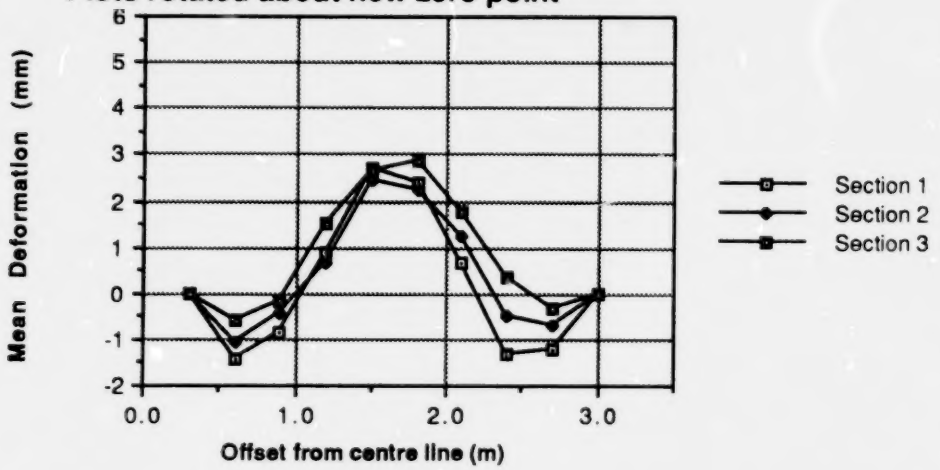
3) It would help the interpretation if all the plots had a common zero. This can be achieved simply by adjusting the curves with respect to the first measurement point adjacent to the centre line. The resulting graphs will then appear as shown in Graph 2.

Graph 2 - Mean Transverse Deformation Zeroed to point adjacent to centre line



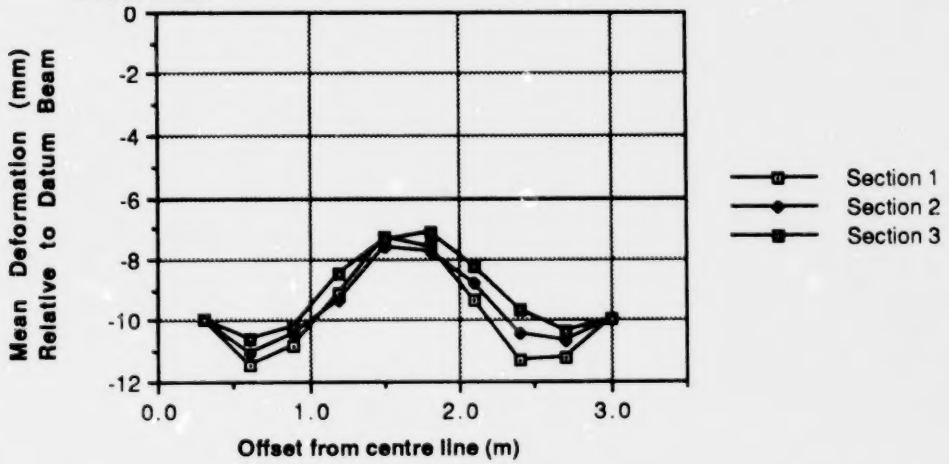
4) This has made the comparison of the sections a little easier but it would be preferable if the measurement point adjacent to the shoulder was also a zero value, i.e. the plots should be rotated about the new zero point adjacent to the centre line. This can be accomplished, to an acceptable accuracy, by proportion, dependent on the difference between the values of the two outside points and the offset of the measurement point being corrected. The resultant graph will then appear as shown in Graph 3.

Graph 3 - Mean Transverse Deformation
Plots rotated about new zero point



5) The transverse deformations are related to an arbitrary point above the pavement surface. The vertical axis can therefore be selected as any convenient scale producing the final plot, Graph 4.

Graph 4 - Mean Transverse Deformation Final Plot



Reporting Results

The final graph is presented so that visual comparisons can be made between the different sections being monitored. The graph may also take the form of a number of plots from the same test section taken at time intervals to show how the deformations are developing.

Bituminous Section
Engineering Materials Office
Downsview

June 1988